Robotically Assisted Unicompartmental Knee Arthroplasty

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Disclosures

- I have no conflicts related to this talk

The problem

- Total knee arthroplasty: Very good to excellent results in majority of patients
- However, persistent subgroup of patients not satisfied
  - does not reproduce the normal kinematics of the knee
- Revision TKA associated with bone loss, extensive OR time, and the risk of morbidity and mortality

Acta Orthopaedica 2009; 80 (1): 55–61

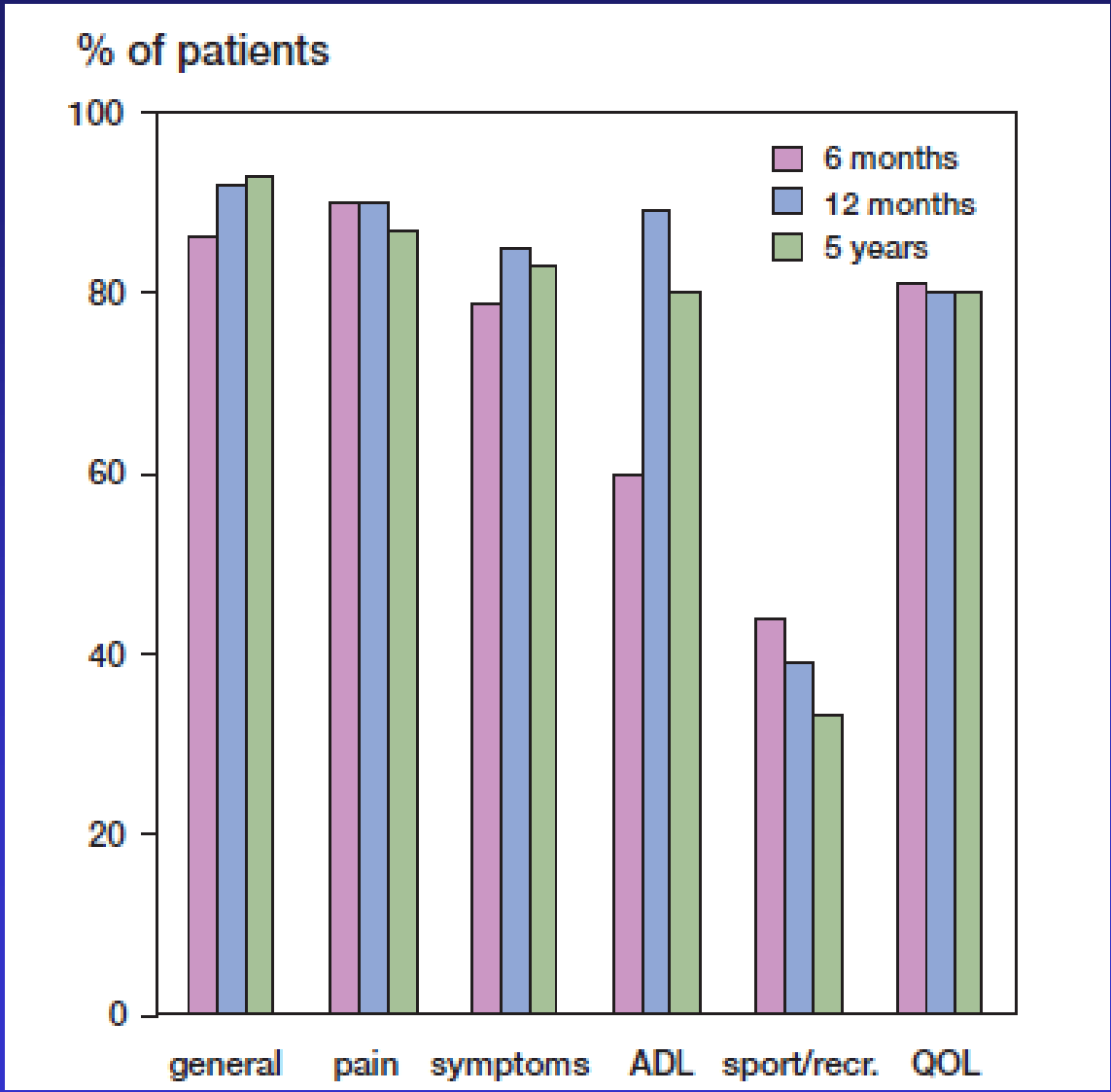
Knee arthroplasty: are patients' expectations fulfilled?

A prospective study of pain and function in 102 patients with 5-year follow-up

Anna K Nilsdotter[1,2], Sören Toksvig-Larsen[2], and Ewa M Roos[2,3]

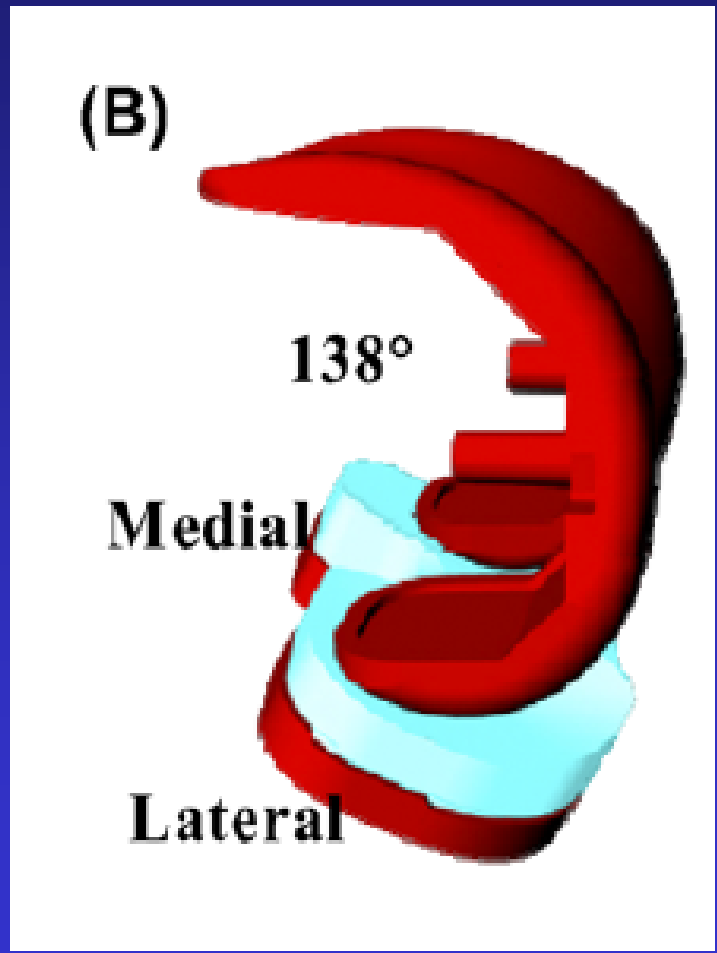
- 102 patients with TKA
- 86% response rate at 5 years
- 41% expected to be able to golf or dance
- 14% able to do so at 5 years
- 93% generally satisfied at 5 years

Satisfaction with TKA by category



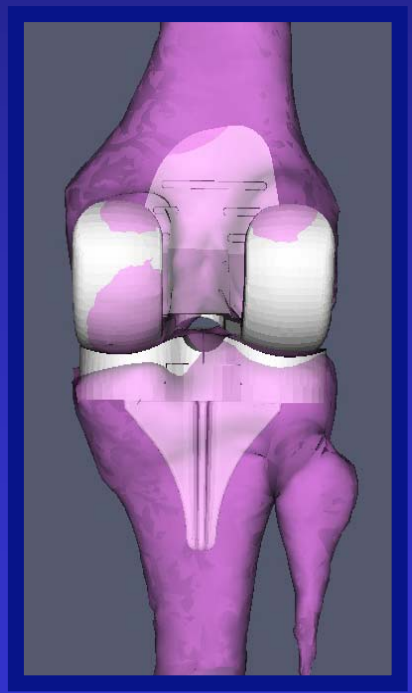
Total Knee Arthroplasty Does Not Reproduce Normal Knee Kinematics

- Paradoxical anterior femoral translation with knee flexion
  - Stiehl et al, CORR 1999
  - Kim et al, J Arthroplasty 1997
  - Dennis et al. CORR 1996
- Lack of rollback of both femoral condyles on posterior tibial plateau of TKA
  - Li et al. JBJS Am, 2006



Possible Solutions?

- Kinematically positioned total knee prostheses
  - Technique for placement of standard TKA prosthesis on the cylindrical flexion/extension axis of the knee (Otismed)
- Limited resurfacing of the joint
  - Meniscus
  - ACL
  - PCL
  - Collateral ligaments
  - Articular cartilage



Courtesy S. Howell, MD

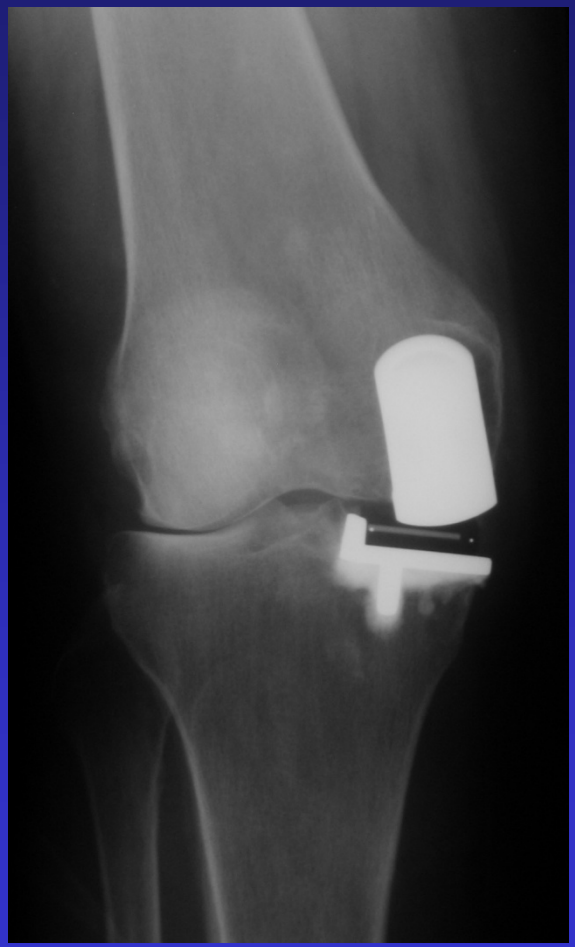
Selective Joint Preservation

- Unicompartmental Knee Arthroplasty
- Patellofemoral Knee Arthroplasty
- Small incisions
- Minimal bleeding
- Less bone loss
- Ease of revision
- “Time buying procedures for the young patient”

History

- UKA has been utilized for over 30 years with clinical success
- Failure mechanisms
  - Opposite compartment OA
  - Subsidence
  - Loosening
  - Malalignment
  - Patellofemoral Impingement
  - Late ACL insufficiency with excessive posterior slope

Technical Problems



Acta Orthopaedica 2010; 81 (1): 90–94

Unicompartmental knee arthroplasty in patients aged less than 65

Combined data from the Australian and Swedish Knee Registries

Annette W-Dahl[1], Otto Robertsson[1], Lars Lidgren[1], Lisa Miller[2], David Davidson[3], and Stephen Graves[3]

- 16,000 UKAs in patients under age 65
- Both countries w similar revision rates
- Has decreased as a percentage of all TKAs over the past decade in both countries

Revision Rates of UKA

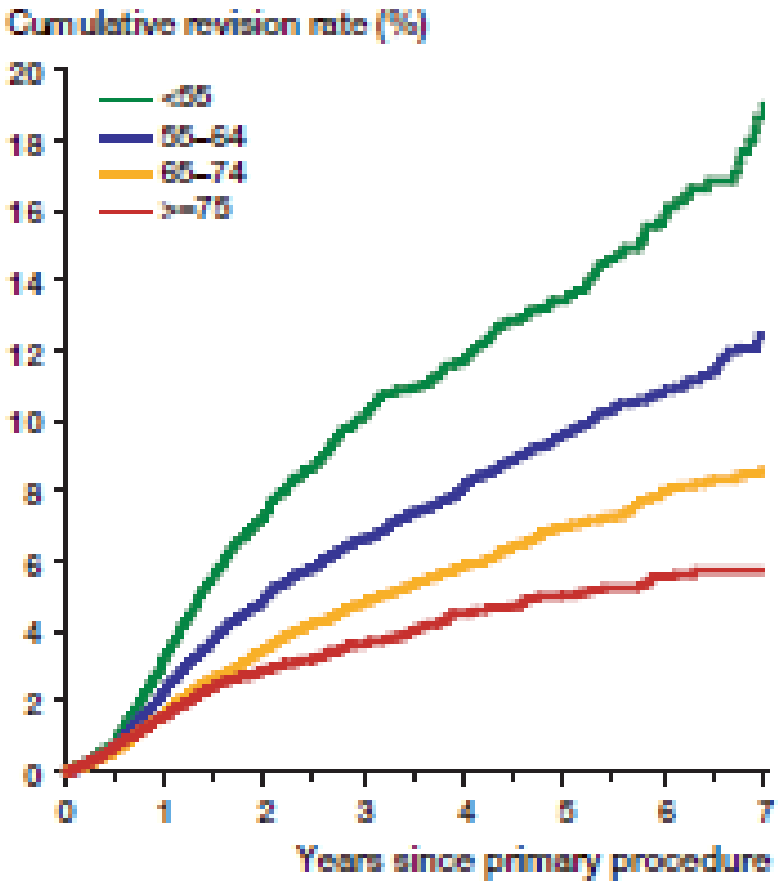


Figure 2. Cumulative revision rate of primary UKA for OA in Australia and Sweden, by age.

What do we need to improve on?

- Materials
  - Heat treated polyethylenes and constrained designs have been eliminated
  - Femoral components have been reinforced to avoid fracture (early St. George Sled design)

Why do we need a robotic assist?

- Alignment
  - Avoidance of coronal plane alignment errors
    - Edge-loading of polyethylene
  - Excessive tibial posterior slope
    - Late ACL ruptures
- Fractures
  - Tibial fractures may be eliminated with an inlay technique
  - Maintain integrity of tibial cortical shell
  - Avoid excessive bone resection on tibia

The MAKOplasty® Solution

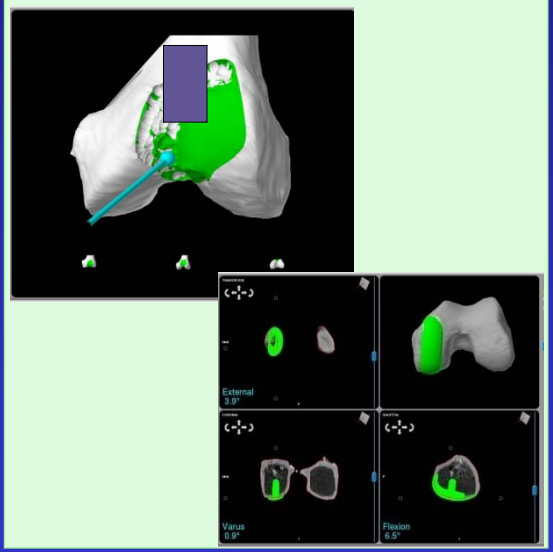
•MAKOplasty®

Consistently Reproducible Precision

•Surgeon Interactive Robotic Arm

RIO™
Robotic Arm Interactive Orthopedic System

•Patient Specific Visualization



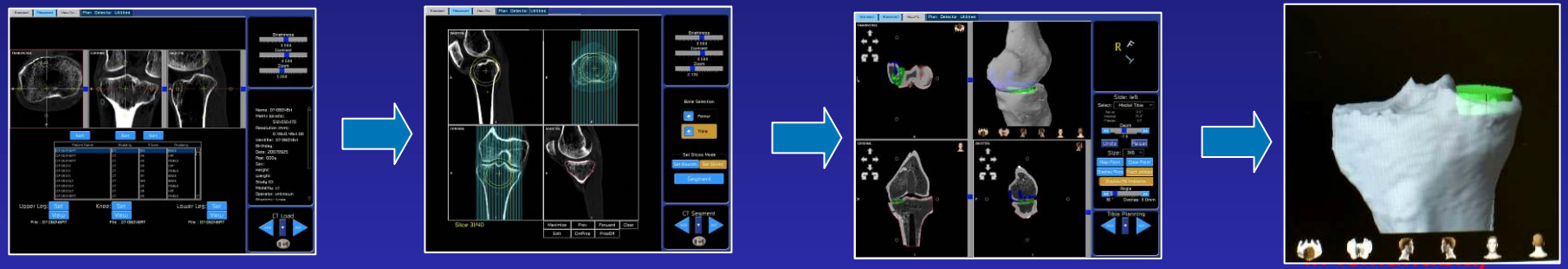
•Going Beyond the Unicompartmental Knee

RESTORIS® MCK
MultiCompartmental Knee System

RIO™ Robotic Arm Interactive Orthopedic System

•Pre-operative Planning

•Supported by MAKOplasty® Specialists

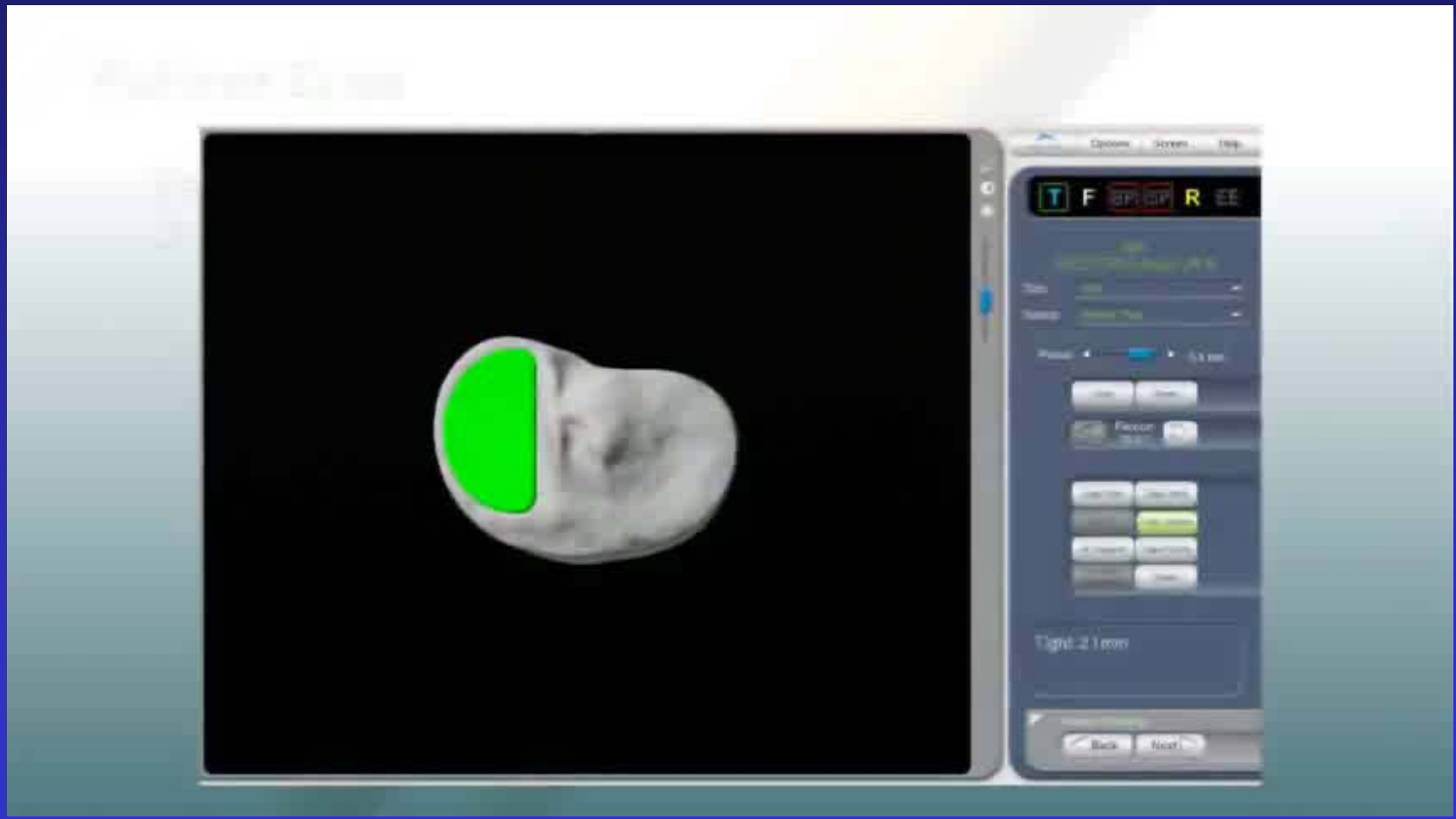


• 3-D reconstruction of the patient's knee

• Patient-specific anatomic planning

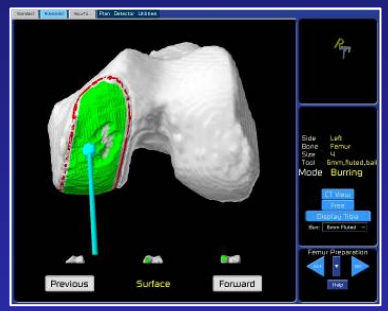
• Assists surgeon with optimal implant position & alignment

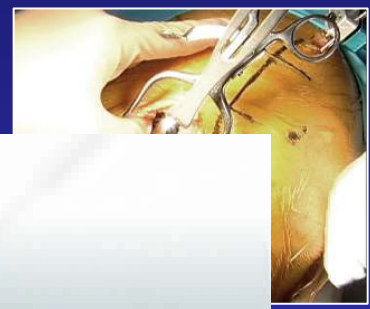
PRE-SURGICAL PLANNING



RIO™ Robotic Arm Interactive Orthopedic System

•MAKOplasty® Intra-operative Flexibility

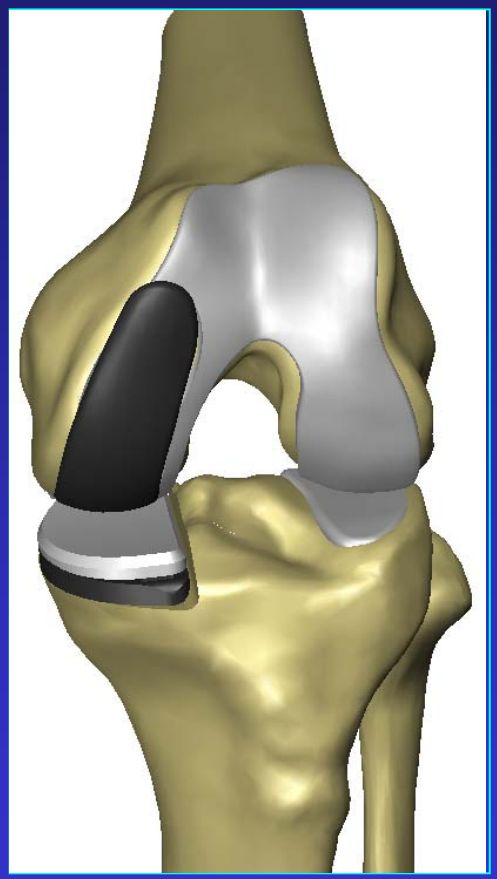




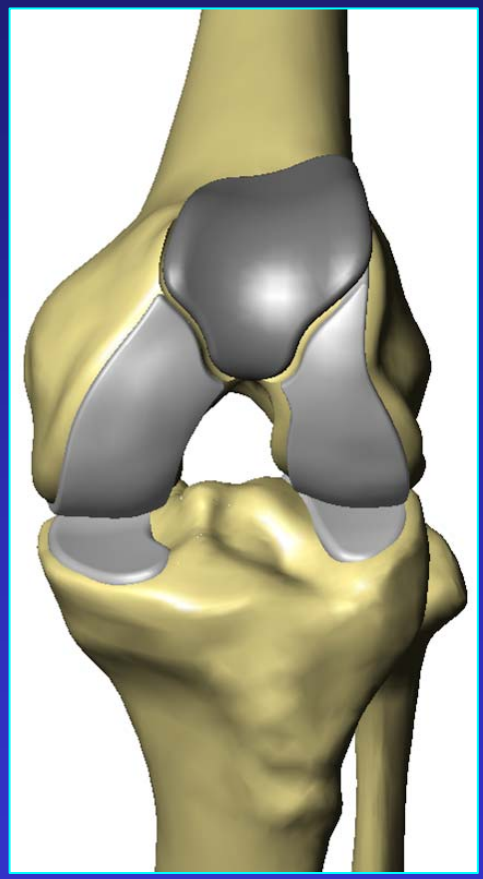
- Virtual instrumentation & tactile feedback
  - Robotic arm facilitates planned cuts
- Minimal soft tissue retraction required for cutting tool only
  - No need for invasive instrumentation
  - Can work through a small, minimal incision
- Real-time virtual visualization inside the knee
  - Confirm implant position & alignment
  - Report on knee kinematics

RESTORIS® MCK MultiCompartmental Knee System

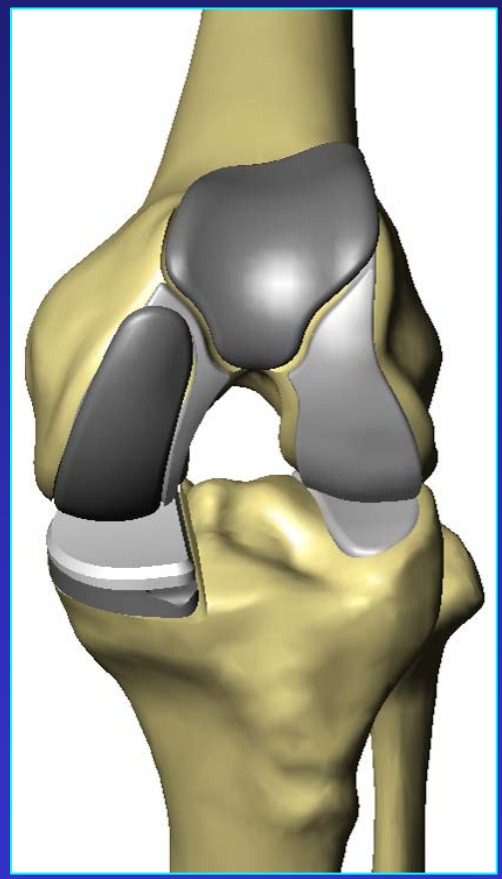
- Targeted solutions for multiple disease states



- Unicondylar



- Patellofemoral



- Bicompartmental

Accuracy of Robotic UKA

Robotic Arm-assisted UKA Improves Tibial Component Alignment

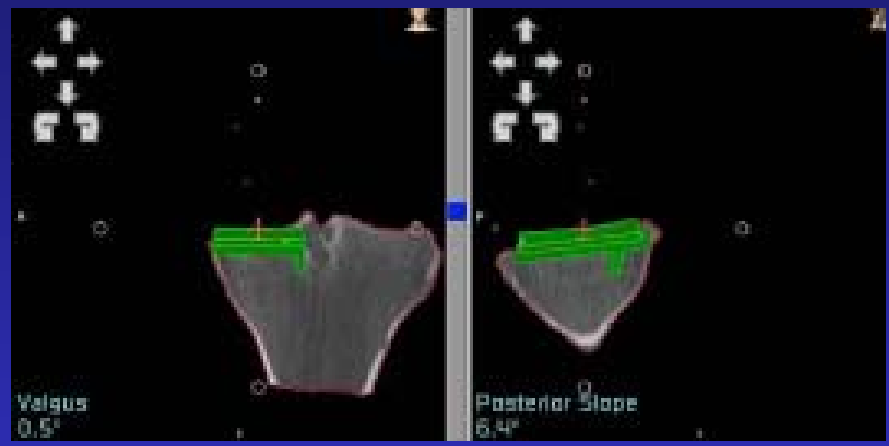
A Pilot Study

Jess H. Lonner MD, Thomas K. John MD, Michael A. Conditt PhD

- CORR 2010
- 31 pts (16 F,15M)
- Average age 64
- Compared to retrospective series of 27 consecutive UKAs performed with conventional instruments

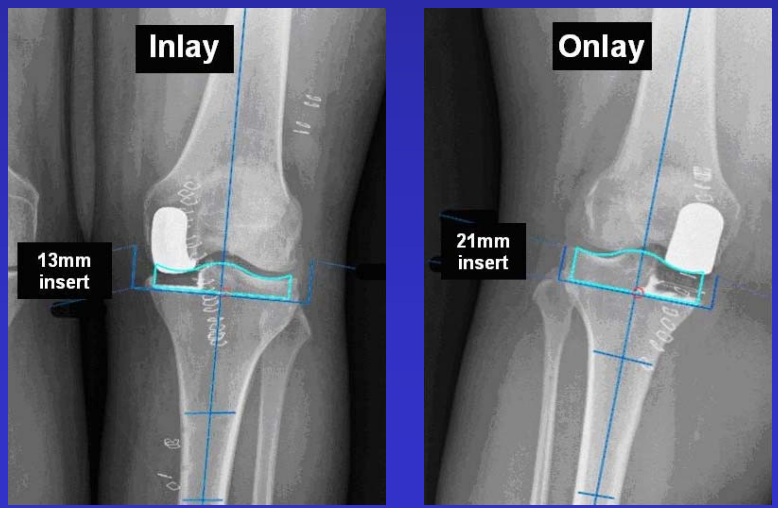
Lonner et al.

- Tibial slope RMS error
  - 3.1 ° manual
  - 1.9 ° robotic
- Coronal plane
  - Tibial alignment error from mechanical axis
    - 2.7° ± 2.1° manual
    - 0.2° ± 1.8° robotic



Bone Preservation

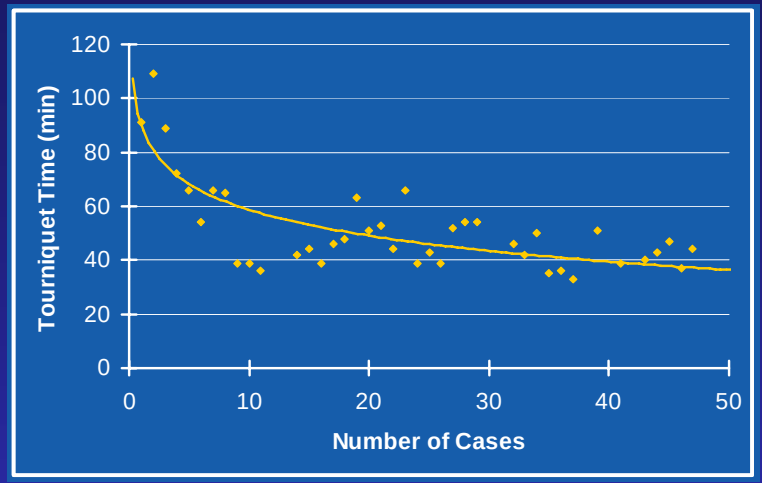
- **Coon et al (2008)**
  - Compared robotically guided inlay to manual onlay UKA implants
  - Average depth of resection:
    - **Inlay = 3.7 ± 0.8mm**
    - **Onlay = 6.5 ± 0.8mm**



- **Kreuzer et al (2008)**
  - Compared 26 robotically guided UKA with 16 all-poly manual MIS resurfacing UKA
  - Average depth of medial bony plateau resection:
    - **Robot Assisted = 4.4 ± 0.9mm**
    - **Manual = 8.5 ± 2.3mm**
    - At conversion to TKA, it was predicted that **75%** of manual group and only **4%** of robotically guided group would require augmentation

Learning Curve

- **Jinnah et al (2008)**
  - 781 robotically guided UKA procedures performed by 11 surgeons
  - Each surgeon performed at least 40 surgeries with the new technology



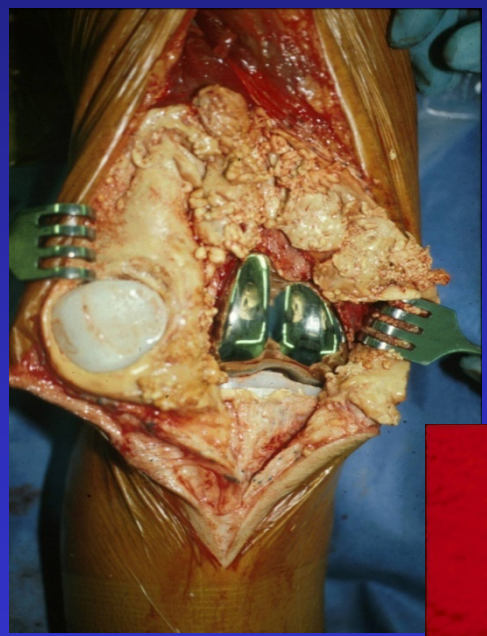
- Average surgical time (all surgeries): 55 ± 19min
- Min steady state time: 38 ± 9min
- Max steady state time: 64 ± 16min
- Average learning curve: 14 surgeries (range: 5 to 29)

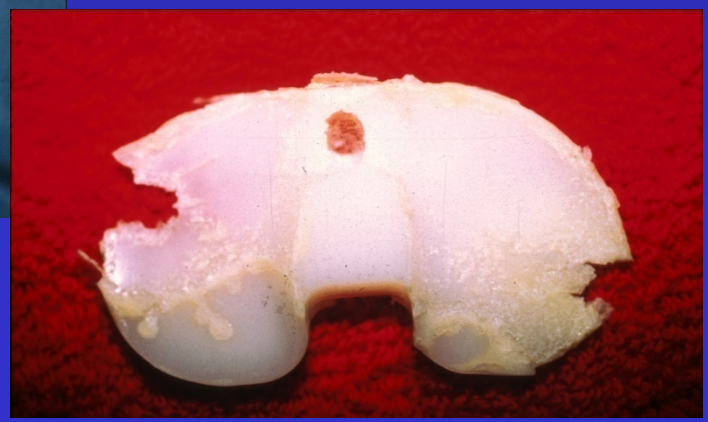
Remaining Questions

- Many of the same issues dealt with in first generation surgical navigation
  - Cost
  - Effect of pins in femur and tibia
  - Increased OR time
  - Most importantly…. CLINICAL OUTCOME

Summary

- Total Knee Arthroplasty is a great operation… but not a perfect operation
  - Incision length
  - Persistent pain
  - Instability
  - Infection
  - Implant Costs
  - Wear
  - Slow Recovery





Summary

- An incremental approach to the surgical treatment of knee arthritis
  - Maintain kinematics
  - Smaller incisions
  - Faster recovery
  - The second surgery is “as easy as a primary”

Summary

- Robotic assisted UKA has been shown to have improved accuracy and precision over standard UKA
- No improvement in clinical outcomes has been shown due to lack of long term outcomes
- Registry data is not available at this time

Thank You!